TITLE: Summary and Outlook - Research Challenges

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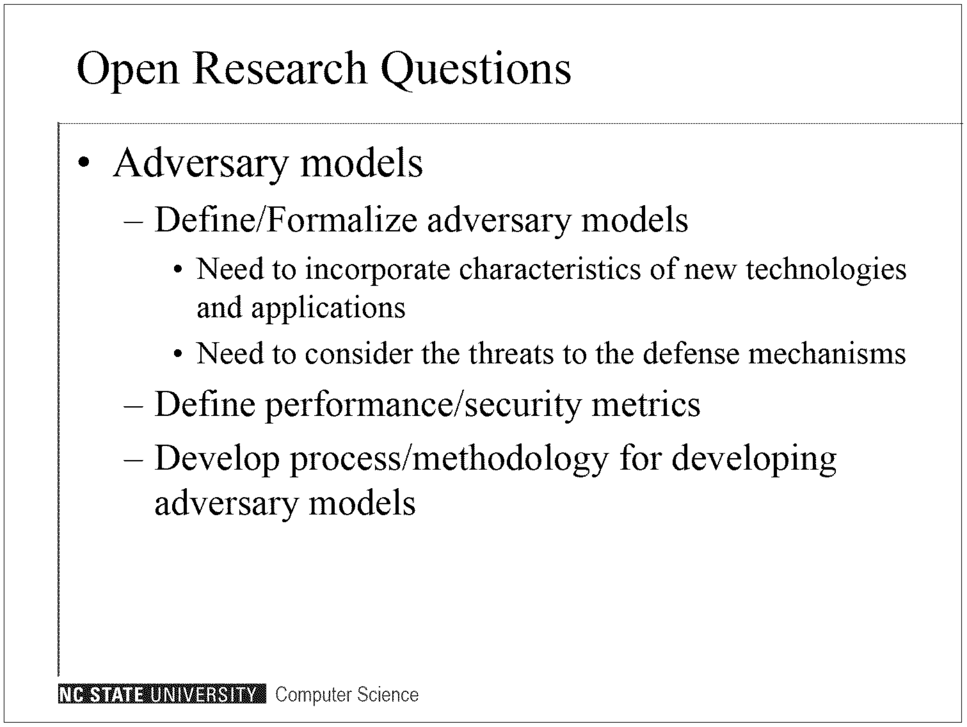
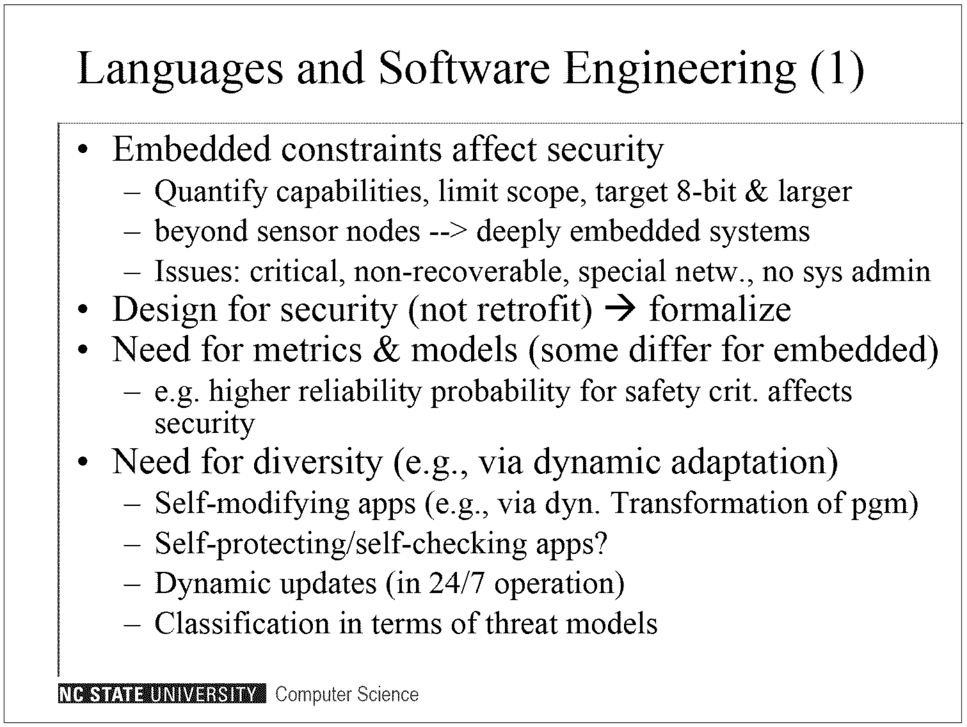
Summary and Outlook – Research Challenges



Open Research Questions

- Adversary models
  - Define/Formalize adversary models
    - Need to incorporate characteristics of new technologies and applications
    - Need to consider the threats to the defense mechanisms
  - Define performance/security metrics
  - Develop process/methodology for developing adversary models



Languages and Software Engineering (1)

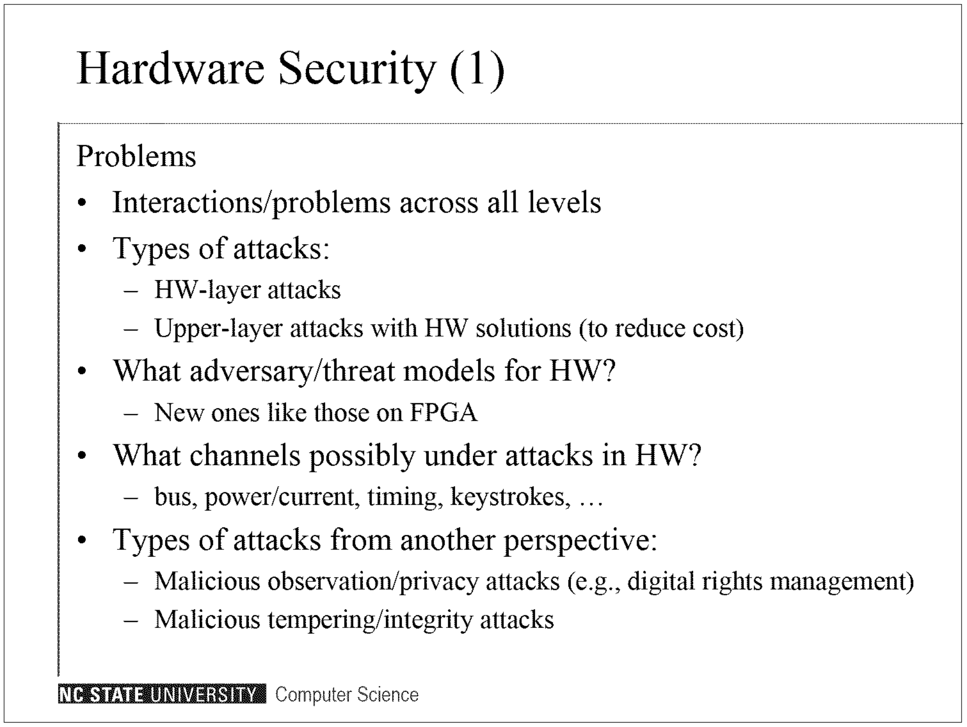
- Embedded constraints affect security
  - Quantify capabilities, limit scope, target 8-bit & larger
  - beyond sensor nodes --> deeply embedded systems
  - Issues: critical, non-recoverable, special netw., no sys admin
- Design for security (not retrofit) → formalize
- Need for metrics & models (some differ for embedded)
  - e.g. higher reliability probability for safety crit. affects security
- Need for diversity (e.g., via dynamic adaptation)
  - Self-modifying apps (e.g., via dyn. Transformation of pgm)
  - Self-protecting/self-checking apps?
  - Dynamic updates (in 24/7 operation)
  - Classification in terms of threat models

Languages and Software Engineering (2)

- Need to limit overhead, retain predictability, low cost
- Incorporate real-time requirements
  - Hard timing constraints limit security options
  - may undermine existing network protocols, add overhead…
  - Interface b/w RT and non-RT components problematic
  - Embedded clients + server need protection of both
- Need hardware assistance

Software Security

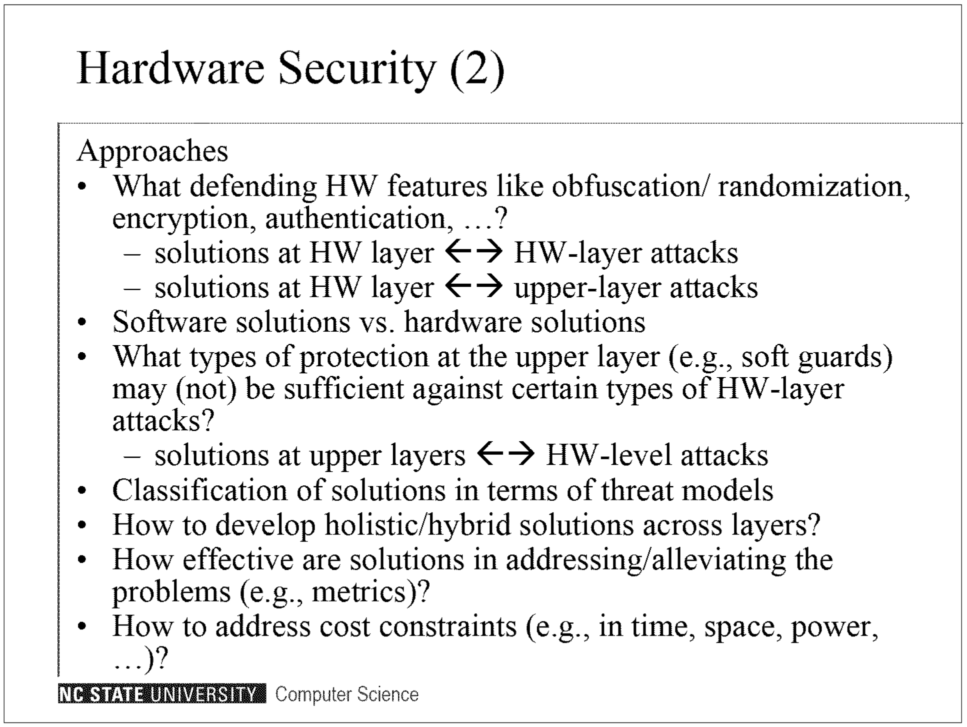
- Can light-weight, effective, semantics-based, compiler-level reasoning systems to characterize program behavior, mal-ware, etc be built?
- Can effective hybrid reasoning systems be built by combining static analysis and runtime monitoring systems?
- Can evaluation contexts be characterized to simplify and reduce efforts in reasoning about software artifacts?
- How can binaries be reasoned about without too many false alarms?
- Can binaries be instrumented to discover security threats and to degrade gracefully in the event of a security fault?
- How to characterize threats, vulnerabilities,…?
- How to build provably correct core components of OS against specific threat definitions?
- Code integrity to leverage to achieve system security.
- Secure and scalable software update on deployed systems.
- Tool support for code obfuscation.



Hardware Security (1)

Problems

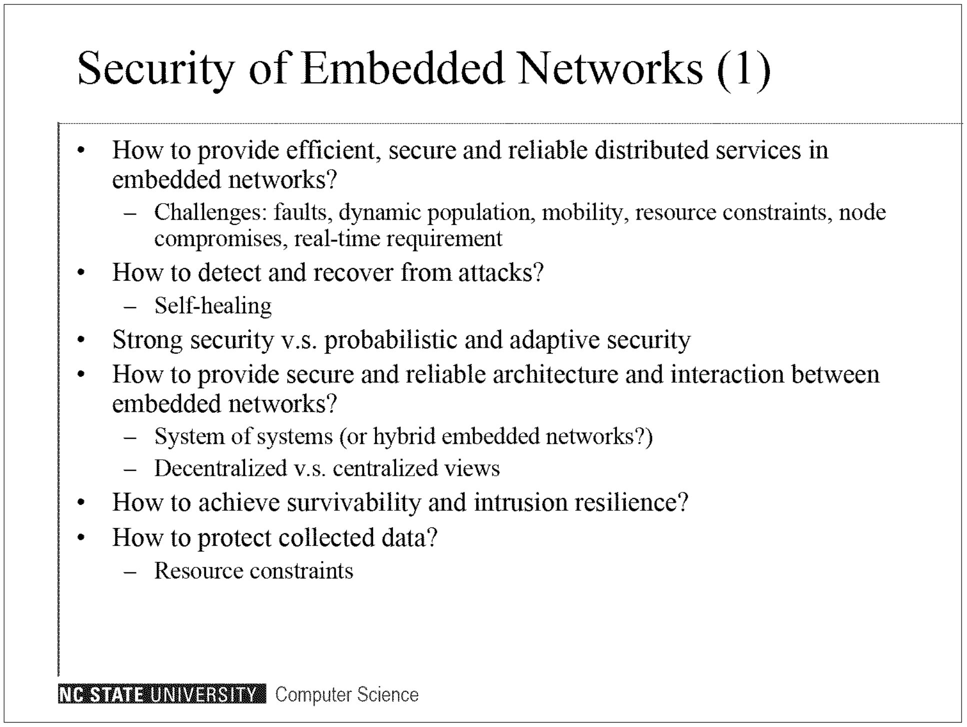
- Interactions/problems across all levels
- Types of attacks:
  - HW-layer attacks
  - Upper-layer attacks with HW solutions (to reduce cost)
- What adversary/threat models for HW?
  - New ones like those on FPGA
- What channels possibly under attacks in HW?
  - bus, power/current, timing, keystrokes, …
- Types of attacks from another perspective:
  - Malicious observation/privacy attacks (e.g., digital rights management)
  - Malicious tempering/integrity attacks



Hardware Security (2)

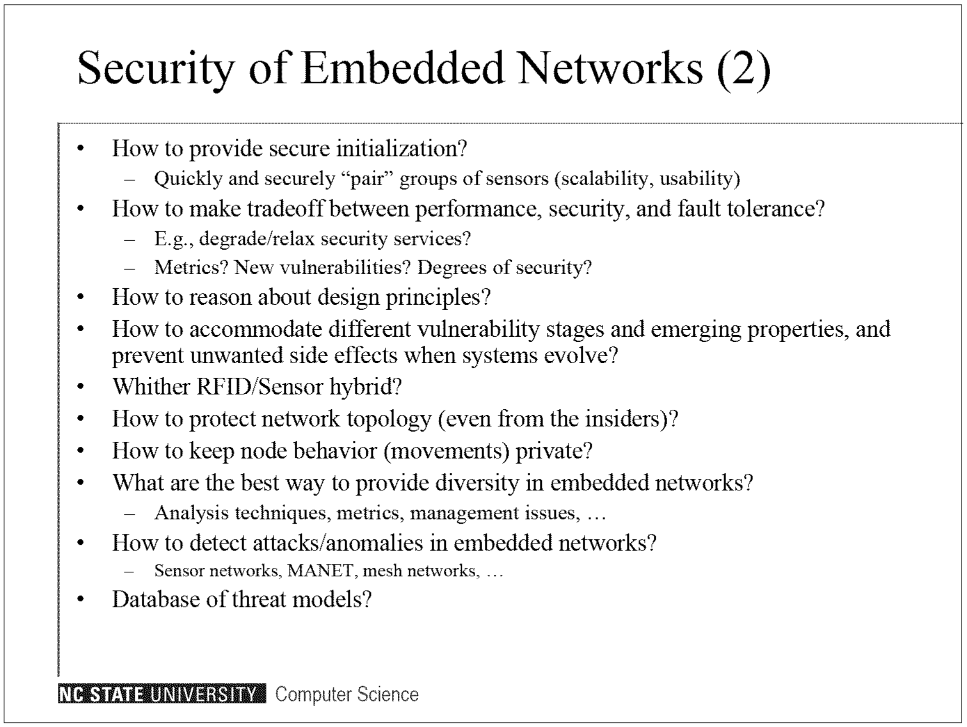
Approaches

- What defending HW features like obfuscation/ randomization, encryption, authentication, …?
  - solutions at HW layer ←→ HW-layer attacks
  - solutions at HW layer ←→ upper-layer attacks
- Software solutions vs. hardware solutions
- What types of protection at the upper layer (e.g., soft guards) may (not) be sufficient against certain types of HW-layer attacks?
  - solutions at upper layers ←→ HW-level attacks
- Classification of solutions in terms of threat models
- How to develop holistic/hybrid solutions across layers?
- How effective are solutions in addressing/alleviating the problems (e.g., metrics)?
- How to address cost constraints (e.g., in time, space, power, …)?



Security of Embedded Networks (1)

- How to provide efficient, secure and reliable distributed services in embedded networks?
  - Challenges: faults, dynamic population, mobility, resource constraints, node compromises, real-time requirement
- How to detect and recover from attacks?
  - Self-healing
- Strong security v.s. probabilistic and adaptive security
- How to provide secure and reliable architecture and interaction between embedded networks?
  - System of systems (or hybrid embedded networks?)
  - Decentralized v.s. centralized views
- How to achieve survivability and intrusion resilience?
- How to protect collected data?
  - Resource constraints



Security of Embedded Networks (2)

- How to provide secure initialization?
  - Quickly and securely “pair” groups of sensors (scalability, usability)
- How to make tradeoff between performance, security, and fault tolerance?
  - E.g., degrade/relax security services?
  - Metrics? New vulnerabilities? Degrees of security?
- How to reason about design principles?
- How to accommodate different vulnerability stages and emerging properties, and prevent unwanted side effects when systems evolve?
- Whither RFID/Sensor hybrid?
- How to protect network topology (even from the insiders)?
- How to keep node behavior (movements) private?
- What are the best way to provide diversity in embedded networks?
  - Analysis techniques, metrics, management issues, …
- How to detect attacks/anomalies in embedded networks?
  - Sensor networks, MANET, mesh networks, …
- Database of threat models?